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COMPARATIVE EFFECT OF AQUEOUS MORINGA EXTRACTS (LEAF AND POD) AS FOLLIAR FERTILIZER ONCOCOYAM YIELD

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Abstract

The use of aqueous moringa extract (leaf and pod) as a foliar fertilizer was studied in the cocoyam research farm, National Root Crop Research Institute, Umudike, Abia State. The study was aimed at determining the effect of the extracts on the yield of two cultivars of Cocoyam. Extracts were produced by milling moringa leaf and pod separately, and diluted with water at the ratios of 1:1 and 2:1(v/v) each. The experimental design was a 5x2 factorial in a randomized complete block design replicated three times. The factors are; five treatments (control, AMPE 1:1, AMPE 2:1, AMLE 1:1 and AMLE 2:1), and two Cocoyam cultivars (NCe 001 and 012). Each replicate had 10 treatment combinations. Treatments were applied on plant leaves at 4, 8, 12 and 16 weeks after planting. Data collected were growth (number of plant stands at harvest), and yield (weight and number of corms and cormels). The results indicate that the AMPE gave better yield than AMLE. When compared with the control, all the treatments gave higher yield, with AMPE 2:1 having higher yield of about 20% on NCe 012 and AMPE 1:1 with about 50% on NCe 001. Amongst the two cultivars, there were significant differences in their yield, with better performance from NCe 012. Results showed that moringa extract can be considered as a good organic foliar fertilizer for enhanced yield of Cocoyam. This is attributed to its composition of growth hormones and nutrients which are present in sufficient quantities and suitable proportions, capable of increasing growth and yield of various crops.

Keywords: *Moringa oleifera*, Cocoyam cultivars, AMLE, and AMPE

Introduction

Cocoyam is a monocotyledonous and herbaceous crop with characteristics of being an underground stem. They are warm weather crops that require an average daily temperature of about 25°C and rich alluvial soils with large quantities of moisture and organic matter (Uguru, 1996). It can also tolerate some degree of flooding and shade. Cocoyam is majorly grown in the tropical and subtropical regions of the world especially in Africa, where it is cultivated for food (Maduewesi and Onyike, 1981) mainly by peasant farmers especially in Nigeria (Knipscheer and Wilson, 1980). Corms and cormels or setts are commonly used by farmers as planting material (Knipscher and Wilson, 1980; Unamma *et al*., 1985). In South-East Nigeria, the three broad varieties of cocoyams majorly cultivated are *Ede ofe*, *Ugwuta* and *Okpakara*. It has a six months life cycle, but survives from year to year by means of the corms and cormels. Root formation and shoot growth takes place immediately after planting, which declines at about six months after planting. All through the growing period, there is rapid turnover of leaves, as new ones continually unfurl from the centre of the whorl of leaves, and the oldest ones below die off.

Corm formation begins at about three months after planting and cormel formation follows afterwards, especially in cultivars that produce large cormels. By the sixth month when the growth declines, and this corms and cormels are not harvested, they will sprout and give rise to new plants at the onset of the next favourable season. The majority of cocoyam growers in the Southeastern part of Nigeria do not use fertilizer. Some even believe that fertilizers diminish the quality and storability of their cocoyam, even though cocoyam has been found to respond well to fertilize, manure and compost. The specific fertilizer types and quantities recommended vary widely from place to place. In general, it is best to apply the fertilizer, compost or manure as a split dose. The first portion is applied at planting, possibly incorporated into the soil during land preparation. This first dose promotes early plant establishment and leaf elaboration. The second dose is supplied 3-4 months later when the corm enlargement is well established. Splitting the fertilizer dose minimizes the effects of leaching which is potentially high in the

high-rainfall areas where cocoyam is produced. Other sources of fertilizers such as bio-fertilizer can be used to improve crop yield.

Moringa oleifera Lam. has attracted much attention in the recent times due to its multiple uses and benefits to the agricultural and industrial sector (Ashfag *et al*., 2012). Moringa is referred to as a miracle tree because all parts of the plants are used for medicinal and other purposes. The roots, flowers, bark, stem, leaves and seeds of moringa possess antimicrobial properties (Anjorin *et al.,* 2010; Dwivedi and Enespa, 2012). Recently, the roles of aqueous extracts of various parts of moringa in improving plant growth and productivity have been explored, making it a more valuable plant (Fahey, 2005). Moringa extract has proven to improve growth and yield when applied as foliar fertilizer as it contains some plant hormones that encourage growth.

Plant hormones have the potential of improving yield, due to their involvement in every stage of plant growth and development.Such hormones that regulate growth are auxins, gibberellins, abscisic acid, ethylene and cytokinins (Prosecus, 2006). Zeatin is one form of naturally occurring cytokinin in plants. Fresh Moringa leaves have been shown to have high zeatin content (El Awady, 2003). Moringa leaf extract was sprayed onto leaves of onions, pepper, soya beans, sorghum, coffee, tea, melon and maize, and was shown to increase yields of these crops (Fuglie, 2000). The urge of cocoyam farmers to increase yield and break even with the demand has led to several research on different approaches to increase yield.However the use of aqueous moringa extract as foliar fertilizer for cocoyam has not been widely researched on. The objective of this study therefore, is to determine the effects of aqueous moringa leaf and pod extract on the yield of two cocoyam cultivars (NCe 001 and 012).

Materials and Methods

Experimental Site

The experiment was carried out at the Cocoyam experimental farm, National Root Crop Research Institute, Umudike, Abia State, South-East Nigeria (Longitude 07°33'E, Latitude 05°29'N) in the rainforest agro-ecological zone. The climate is humid tropical with annual rainfall that ranges from 2000mm to 2500mm, and average temperature which ranges between 26°C and 35°C. The rainfall pattern has distinct wet season (April to October) and dry season (November to March) (NRCRI, 2016). The soil is a coarse-textured Ultisols. Selected physicochemical properties of the soil are shown in Table 1.

Preparation of moringa extracts

The plant parts (leaves and pod coats) of *Moringa oleifera* collected were washed under tap water, followed by distilled water and dried in shade. Dried samples were powdered in grinder. Powders of leaves and pod coats were mixed individually with distilled water in a ratio of 1:1 and (w/v) and left overnight to allow the constituents to get dissolved in water, then filtered through muslin cloth and 100% plant extract solution was prepared. The extract obtained was subjected to the vacuum filtration followed by shaking. The processed 100% extracts were poured in the Erlenmeyer flasks, plugged with cotton separately, and heated at 50°C for 15 minutes to avoid contamination. The extracts were further diluted using distilled water to different concentration of ratios 1:1 and 2:1 (i.e five mls of extract to five mls of water and ten mls of extract to five mls of water respectively) for further use in the experiment.

Experimental Layout and treatment

The field was cleared, ploughed, harrowed and ridged. The ridges were made 1m apart in a plot size of 5m by 4m with a furrow of 0.5m, with 20 stands per plot. Each plot was spaced 1m apart and the total plots were 30.The five treatments used were; Control. (Con), Moringa leaf extract 1:1 (v/v) (AMLE 1:1), Moringa leaf extract 2:1 (v/v) (AMLE 2:1), Moringa pod extract 1:1 (v/v) (AMPE 1:1), and Moringa pod extract 2:1 (v/v) (AMPE 2:1). The experimental design was a 2 factorial Randomised Complete Block Design with three replicates (i.e. 5x2x3 RCBD). The two factors arefive treatmentsand two cocoyam cultivars (NCe001 and NCe 012). The five treatments were combined randomly with the two cocoyam cultivars to produce 10 treatment combinations, each replicated two times.

Planting and Weeding

The crop used for the experiment was cocoyam (Colocasia-NCe001 and 012), the cocoyam was obtained from National Root Crop Research Institute Umudike. Planting was done at a spacing of 1m by 1m with one corm sown per planting hole on the crest of the ridge at the depth of 15cm, given a total plant population of 20 plants per plot. Weeding was manually done with hoe at 2, 8, 13 and 17 weeks after planting.

Treatment application and data collection

The treatment application started a month after planting and was done repeatedly at monthly intervals. Growth data taken was plant stand at harvest (survival count). The yield components taken are number of corms, number of cormels, weight of corms, weight of cormels (kg), and number and weight of corms and cormels.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using linear model procedure appropriate for an experiment in RCRD, with SAS software. The least significant difference (LSD) test was used to separate significant means at 5% level of probability.

Results and Discussion

The Physicochemical properties of Soil and Aqueous moringa extract

The properties of the soil measured from the experiment (Table 1) indicate the textural class is sandy loam, with lower content of silt than clay. As at sampling, it showed slightly acidic condition and relatively high phosphorus content. The nitrogen and potassium were low, while

organic carbon, calcium and magnesium were moderate, according to Landon (1991). The analysis of the aqueous moringa extract used in the study (Table 2) showed that moringa leaves had higher nutrient values than the pods.

Table 1: Physical and chemical properties of soil used for the experiment

Elements	Values
pH	4.8
% TN	0.13
% OC	1.60
Avail p (mg/kg)	30.0
Ca (cmol/kg)	1.0
Mg (cmol/kg)	0.55
K (cmol/kg)	0.09
Na (cmol/kg)	0.08
EA (cmol/kg)	3.80
Ecec (cmol/kg)	5.52
%bs	35.8
Sand	80
Silt	3
Clay	17
Silt clay	0.20
Texture	Sandy loam

Table 2: Properties of Moringa leaves and pod

Elements	Pods	Leaves
Water %	86.9	7.8
Calories	26	205
Protein(g)	2.8	30.08
Fat (g)	0.15	2.3
Carbohydrates (g)	5.7	45.2
Fibre (g)	9.8	19.2
Minerals		
Ca (mg)	30	2003
Mg (mg)	24	368
P (mg)	110	204
K (mg)	259	1324
Cu (mg)	3.1	0.057
Fe (mg)	5.3	28.2
S (mg)	137	870
Oxalic acid (mg)	10	1.6
Vitamin A- Beta carotene (mg)	0.11	
Vitamin B- Choline (mg)	389	_
Vitamin B1- Thianine (mg)	0.1	2.28
Vitamin B2- Riboflavin(mg)	0.07	98.5
Vitamin B3- Nicotinic acid (mg)	0.2	8.2
Vitamin C- Ascorbic acid (mg)	130	15.3
Vitamin E- Tocopherol acetate (mg)	_	110

Effects of Moringa leaf and pod extracts on the yield of Cocoyam (NCe 001)

The result in Table 3 shows that there is no significant difference amongst the treatments on the survival count, number of cormels, weight of comels, and number of corms and cormels of NCe 001. Number of corms, weight of corms and total weight had significant differences amongst treatments. Generally,all the treatments had higher yield than the T1(control), but treatment T4(AMPE 1:1) had the highest yield of about 50% compared with the control. This could be as result of the nutrient composition of the pods. Although results have shown that moringa leaf extract improved crop yield (Fuglie, 2000; Adekiya *et al*., 2017). In this experiment it was observed that moringa pod extract at ratio 1:1 v/v performed better than the leave extracts

Table 3: Treatment effects on cocoyam (NCe 001)

Treatments	Survival count	No of corms	Weight of corms (kg)	Number of cormels	Weight of cormels (kg)	Number of corms and cormels	Total weight (kg)
T1 (Control)	14.00a	16.33b	0.90b	109.00a	2.20a	125.65a	3.10b
T2 (AMLE 1:1)	14.33a	17.00b	2.03b	143.67a	3.87a	187.33a	5.90a
T3 (AMLE 2:1)	16.67a	24.00ab	1.23ab	163.00a	3.40a	160.67a	4.63ab
T4 (AMPE 1:1)	17.67a	32.00a	2.07a	156.67a	4.10a	188.67a	6.17a
T5 (AMPE 2:1)	14.33a	16.67b	1.17ab	145.00a	3.33a	161.67a	4.50ab

T- Treatment, AMLE-Aqueous moringa leaf extract, AMPE-Aqueous moringa pod extract

Effects of Moringa leaf and pod extracts on the yield of Cocoyam (NCe 012)

The results in Table 4 show no significant difference amongst the treatments on the survival count, number of cormels, weight of comels and total weight (weight of corms and cormels) of the NCe 012 cultivar. Survival count, number of corms, weight of corms and number of corms and cormels had significant differences amongst treatments. Generally, all the treatment had higher yield than the T1(control), but treatment T5 (AMPE 2:1) had the highest yield of about 20% compared with the control. This reveals that the NCe012 cultivar requireshigher concentration of the extract for effective increase in yield.Similar to the treatment effects on NCe 001, all the treatment extracts had higher yield compared to T1(control). This corresponds with the findings of Culver *et al*. (2012), that moringa leaf extract increases growth and yield of tomatoes.and the greater the frequency of application.the greater the increase in yield. In this experiment it was observed that moringa pod extract at ratio 2:1 v/v performed better than the leave extracts.

Table 4: Treatment effects on cocoyam (NCe 012)

Treatments	Survival count	No of corms	Weight of corms (kg)	Number of cormels	Weight of cormels (kg)	Number of corms and cormels	Total weight (kg)
T1 (Control)	19.33ab	23.67b	2.87b	249.67a	6.00a	273.34b	8.87a
T2 (AMLE 1:1)	16.33b	32.67a	3.60ab	273.00a	6.50a	305.67ab	10.10a
T3 (AMLE 2:1)	19.00ab	31.67ab	3.27ab	270.67a	6.37a	302.34ab	9.64a
T4 (AMPE 1:1)	16.67b	30.33ab	2.90b	267.00a	6.23a	397.33a	9.13a
T5 (AMPE 2:1)	20.00a	38.33a	3.90a	316.00a	7.23a	354.33ab	11.13a

T- Treatment, AMLE-Aqueous moringa leaf extract, AMPE-Aqueous moringa pod extract

Yield performance of cocoyam cultivars (NCe 001 and 012)

The result in Table 5 shows that there were significant differences amongst the cultivars (NCe 001 and NCe 012) in all the yield parameters. This shows that NCe 012 produced higher tuber yield when compared with NCe 001, and responds better to addition of treatments

Table 5: Yield performance of two cocoyam cultivars (NCe 001 and 012)

Treatments	Survival count	No of corms	Weight of corms (kg)	Number of cormels	Weight of cormels (kg)	Number of corms and cormels	Total weight (kg)
NCE 001	15.72	22.22	1.47	150.83	3.47	173.06	4.94
NCE 012	20.56	33.17	3.39	276.78	6.52	**309.94**	**9.91**
LSD (0.05)	1.52	3.93	0.42	37.61	0.82	38.26	1.24

Moringa leaf and pod extract has proven to be a good alternative source of organic fertilizer. It has been reported that foliar application of moringa leaf extract improved the growth and yield of tomatoes, peanut, corn and wheat during the vegetative growth stage of the crops, and also of moringa leaf and pod extract also effectively improved the yield of Cocoyam as compared to the control. This is similar to the findings of Fuglie (2000), who reported increase in yield of onions, pepper, soya, maize, sorghum etc. by 25-39%, following the application of moringa leaf extract. The studies therefore suggested that the increase could be due to the presence of zeatin, and also sufficient micro nutrients in the moringa leaf. Also Adekiya *et al*. (2017) reported that the application of moringa leaf extract increased the yield of okra when compared with the control. This report is also similar to our findings. In addition Phiri (2010) reported that *M. oleifera* leaf extract improved germination of sorghum and increased hypocotyl length of wheat.

Conclusion

The use of plant extract as bio-fertilizers influenced crop yield positively, validating the positive influence of moringa extract on cocoyam yield, and higher yield of NCE 012. The study therefore, concludes that moringa extract, particularly AMPE is a good alternative bio fertilizer for enhanced crop yield, and it performed better than AMLE. Based on the dearth of research on the use of moringa pod extracts, it is recommended that more research is required on the use of moringa pod extract on crop yield.

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